Appendix A

Semiconductor Glossary

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Term (Index)	Definition
silicon dioxide, SiO2	silica; native oxide of silicon and at the same time an excellent insulator; the most common insulator in semiconductor device technology, particularly in silicon MOS/CMOS where it is use as a gate oxide; high quality films are obtained by thermal oxidation of silicon; thermal SiO_2 forms smooth, low-defect interface with Si; can be also readily deposited by CVD; SiO_2 performs various functions in silicon device technology which to large degree depends on outstanding characteristics of; also used in non-Si devices; Key parameters: energy gap Eg ~ 8eV, dielectric strength 5-15 x 10^6 V/cm depending on thickness, dielectric constant k = 3.9, density 2.3 g/cm^3, refractive index n =1.46, melting point ~ 1700 °C; prone to contamination with alkali ions and sensitive to high energy radiation; in semiconductor technology used in the form amorphous thin films; single crystal SiO_2 is known as quartz.
silicon nitride, Si3N4	dielectric material with energy gap = 5 eV and density ~3.0 g/cm^3; excellent mask (barrier) against oxidation of Si; commonlly used in silicon integrated circuit manufacturing primarily

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Notes

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ACADEMIC PRESS, INC.
1250 Sixth Avenue, San Diego, CA 92101

United Kingdom Edition published by
ACADEMIC PRESS, INC. (LONDON) LTD.
24-28 Oval Road, London NW1 7DX

Cover design by Nono Kusuma

Library of Congress Cataloging-in-Publication Data

Murarka, S.P.
Electronic materials : science and technology / Shyam P. Murarka and Martin C. Peckerar.
p. cm.
Bibliography: p.
Includes index.
ISBN 0-12-511120-7
1. Electronics—Materials. 2. Semiconductors. I. Peckerar, Martin Charles, Date– . II. Title.
TK7871.M87 1989
621.3815'2—dc19 88-34033
CIP

Alkaline paper

Printed in the United States of America

89 90 91 92 9 8 7 6 5 4 3 2 1

3 Oxidation

3.1 Introduction

The phenomenal success of silicon as the starting material for the fabrication of integrated circuits lies in the fact that SiO_2 layers can be produced by thermal oxidation of silicon substrates and by deposition from the gas or vapor phase. The oxide films are useful in several ways:

1. They provide isolation between devices.
2. They mask against impurities, dopant diffusion, and environmental effects.
3. They provide stability against mechanical damages, e.g., scratching.
4. They act as an insulating layer between conductors.
5. They act as the gate dielectric.

Basically, the SiO_2 layers can be used in the ways described above successfully. In using such layers as gate dielectric, and for isolation purposes, the demands for control of the dielectric properties are the most severe. Dielectric properties determine transistor thresholds and parasitic leakage currents. For other applications, the requirements are less stringent.

In this chapter, thermal oxidation of a semiconductor surface is considered. Thermal oxidation of silicon in dry oxygen and in water-vapor-containing medium have been the preferred techniques. This is because oxide films produced in this way have the best properties. This chapter deals with the oxidation of silicon. In the last section of the chapter, the oxidation of compound semiconductors, such as GaAs, GaP, and InP, is discussed. For semiconductors other than silicon, the oxidations that produce acceptable oxide films have not been possible. This fact has resulted in less than the expected usefulness of such semiconductors.

3.2 Oxide Properties

Table 3.1 summarizes the most important properties of silicon dioxide. Thermally grown SiO_2 films are amorphous. They consist of a random three-dimensional network of silicon atom tetrahedrally surrounded by four oxygen atoms each [1]. The tetrahedra are joined by oxygen bridges at the corners, as shown in the two-dimensional network depicted in fig. 3.1. As is apparent,